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## challenges science policy
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# Chemical & Engineering NEWS

*Cover:* The "Ark" at New Alchemy Institute near Woods Hole, Mass. A model for appropriate technology, it contains areas for growing vegetables and for producing heating through aquaculture. Photo by C&EN's Wil Lepkowski

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# Major fiber monomers face slump in 1980

**Production declines forecast for cyclohexane, dimethyl terephthalate, and ethylene oxide as major recession cuts into fiber demand**

Starting materials for the two largest-volume U.S. synthetic fibers now appear to be facing a repeat this year of the 1975 recession. Production of dimethyl terephthalate (DMT), purified terephthalic acid (PTA), ethylene oxide, and cyclohexane has begun to slump as the recession intensifies.

Although opinion in the industry varies, consensus is that all of these chemicals will have lower production in 1980 than they had in 1979. The size of the drop will vary depending on markets. Current estimates place the declines on the order of 5 to 10%, but almost everybody qualifies their estimates with a proviso to wait to see how bad the recession becomes.

If the 1975 recession pattern is followed closely, developments in 1980 will differ a bit from current forecasts. In 1975, combined production of DMT and PTA still rose 1%, production of ethylene oxide increased 4%, and cyclohexane output sank 26%.

However, many forecasters now expect 1980 DMT/PTA production to fall below 1979 for the first substantial dip in its history. This forecast assumes that polyester fibers will post a production decline, something they did not do in the previous recession. It also assumes that nonfiber markets for polyester will not grow fast enough to make up for declines of DMT/PTA going to fibers.

By contrast, fibers have less impact on ethylene oxide than on any of the other chemicals; only about 30% of ethylene oxide production goes to polyesters.

In the mid-1970's production of ethylene oxide eventually fell, 4% in 1976, a year later than the decline in most other chemicals. Nonfiber uses of ethylene oxide, particularly antifreeze, apparently were responsible for the drop, since polyesters grew 2% in 1976.

A runup in antifreeze inventories seems to have caused the delayed decline in ethylene oxide production in 1976. Unfortunately, a similar situation may be occurring now.

Antifreeze had a better year in 1979 than many in the industry expected. These sources conclude that inventories are up abnormally and will have to be worked off in 1980. Since about 30% of ethylene oxide production eventually ends up as antifreeze, a 10% decline in antifreeze production expected in 1980 will translate back to ethylene oxide as about a 3% drag against production.

Cyclohexane and nylon were both hit harder and longer by the 1974–75 recession than were DMT/PTA, ethylene oxide, and polyesters. Nylon fiber production didn't get above its pre-1975 peak until 1977, and cyclohexane not until 1979.

The reason for the slower recovery for cyclohexane was a partial shift out of cyclohexane to butadiene as a raw material for the nylon intermediate, hexamethylenediamine. Other influences, such as slack export markets, also apparently slowed cyclohexane's recovery.

All of the fiber materials are forecast for declining exports in 1980. Cyclohexane has the largest export stake, relatively important at about a sixth of production. Exports take only 4% of DMT/PTA production. Exports of ethylene oxide are very small, although exports of derivatives are sizable. Hence, cyclohexane has the most to lose in an export slump.

Exports of downstream fibers could decline relatively more than exports of the starting materials after a booming two years. The main reasons are a spreading business slowdown in Western Europe and efforts in Europe to build trade barriers to U.S. fibers imports.

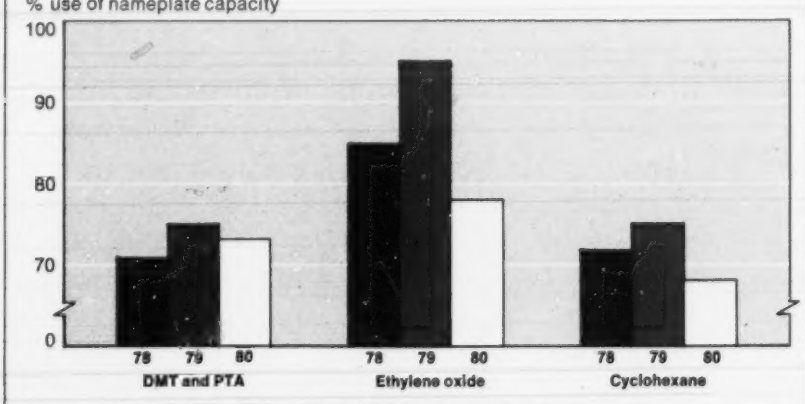
Unhappily, this year profits haven't much of a chance against a combination of the export problem, lower U.S demand, and a rise in some plant capacity. The result will be a notable drop in capacity use with an attending drop in cost efficiencies.

Already, producers of fiber materials are getting downward price pressure. The source is price weakness in upstream raw materials for these chemicals. For example, prices of benzene for cyclohexane are dropping, about 15 cents a gal from $1.80 so far. And prices of *p*-xylene for DMT/PTA are weakening as competing gasoline demand slumps, lowering mixed xylene prices. Ethylene for ethylene oxide has lost at least 0.5 cent of its April price increase of 3.5 cents to about 24.5 cents a lb.

For details of the immediate 12-month outlook for the starting material chemicals, see the following pages.

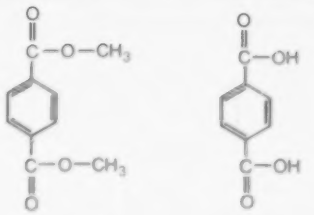
*Bruce Greek, Houston*

**Plant use in fiber monomers will drop this year**



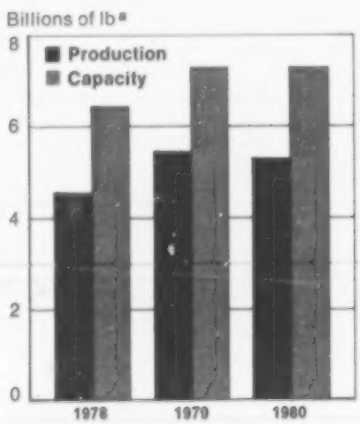

**Sources:** Producers and C&EN estimates, International Trade Commission

# DMT/PTA




- ***Demand declining***
- ***Capacity flat***
- ***Prices softening***

## PRODUCTION/CAPACITY




[a] Total for both DMT and PTA.

## HOW MADE

*For PTA, oxidation of p-xylene; for DMT, oxidation and concurrent esterification with methanol*

## MAJOR DERIVATIVES

*Polyethylene terephthalate almost 100%*

## MAJOR END USES

*Polyester, 95%*

## FOREIGN TRADE

*Exports—Falling in 1980 to 325 million lb, imports—negligible*

## PRICES

*31 cents per lb, DMT; 33 cents per lb, PTA*

## COMMERCIAL VALUE

*$1.4 billion for total production, 1979; $1.7 billion, 1980*

After enjoying a very sunny 1979, U.S. producers of dimethyl terephthalate (DMT) and purified terephthalic acid (PTA) are facing a darker 1980. Production of DMT and PTA in 1979 rose nearly 20% to about 5.5 billion lb. This year, production will be off at least 5% to about 5.3 billion lb.

The radical change in the production growth rate, first noticed in late 1979, fits the traditional pattern for a fibers-related business. DMT and PTA production, nearly all of which goes into polyester, rises and falls quickly over short periods with cyclical moves in fibers. As yet, nonfiber uses of polyester are not large enough to dampen fibers' influence on the monomers. This year, falling polyester fiber shipments bode ill for DMT/PTA.

Given the decline in DMT/PTA production expected during 1980, producers must look to the future for new overall growth. When demand picks up again, plant capacity looks sufficient for a while, even though no new major capacity came on stream during 1979 or will in 1980.

Of course, a couple of years of renewed 10% growth in demand will pretty well eat up the current 25% surplus in capacity. Combined nameplate capacity for DMT and PTA is about 7.3 billion lb per year.

Almost all DMT/PTA goes to make polyethylene terephthalate (PET). Another, but minor, polymer product made from DMT/PTA is polybutylene terephthalate (PBT), using 1,4-butanediol in place of ethylene glycol as the other starting material. PBT, an engineering resin, has had some acceptance problems in potential uses. As a result, its growth rate is large, but not spectacular, from a very small base.

Fibers will consume a bit under 80% of DMT/PTA production in 1980. Apparel dominates these fiber uses with about 60% of the total. Most apparel fabrics are blends with natural fibers such as cotton and wool. However, producers hope that 100% polyester garments will return to favor as improvements are made in the fabrics, notably through use of smaller-sized polyester yarn.

Of the nonfiber uses of DMT/PTA, a bit under 8% will go into films in 1980; an almost equal share will go to containers, mainly soft drink bottles; small quantities will go to specialty chemicals used as intermediates; and the remainder will be exported. Exports are expected to decline as the world economy falters and U.S. producers' costs rise closer to those outside.

In the U.S., film use continues to grow well. However, the growth rate in terms of DMT/PTA consumption will be in the 5 to 6% range in 1980, down from 8 to 10% earlier.

Among specific film uses, photographic films of various types continue to take about 40% of the total. The next largest use, growing faster, is various kinds of magnetic tapes. Most rapidly growing of all film uses is videotape, rising from a small base.

Still, the big jump in DMT/PTA consumption in 1980 will be in containers. Some optimists call for a nearly 50% annual climb in polymer volume from about 235 million lb of PET in 1979 to around 350 million lb in 1980. Hence, containers will keep 1980 from being a rougher year for DMT/PTA than fibers use alone would indicate.

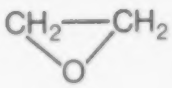
Several factors are spurring the container boom. The most important is promotional work by producers of soft drinks. Other significant factors are increased capacity to make plastic bottles and other containers, and marketing efforts of DMT/PTA producers.

The PET bottle market is not without problems. For one, glass container manufacturers are fighting back with competitive pricing in spite of rising energy costs. For another, most of the volume of plastic bottles is confined to large-size soft drink containers because the cost advantage of glass is less for large sizes. Finally, recycling could become a problem, but experiments have begun to recycle PET bottles into insulating-type fibers.

Depending on promotional campaigns and on adaptation of PET to smaller-size bottles, the market for these bottles could continue to grow at high rates. The resulting increase in demand for DMT/PTA would be between 100 million and 150 million lb annually for the next three years.

For DMT/PTA, then, some newer consumer products will make 1980 a slightly better year than it would be if fibers had full market control.

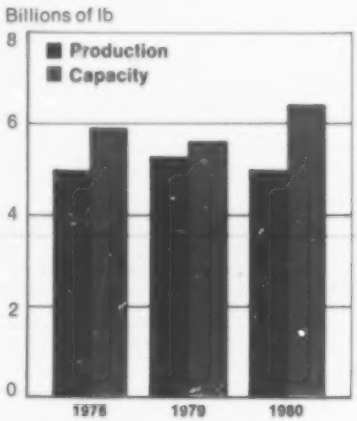
## Key Chemicals



# Ethylene Oxide

- ***Demand slowing***
- ***Capacity rising***
- ***Prices weakening***

### PRODUCTION/CAPACITY




### HOW MADE

*Vapor-phase catalytic oxidation of ethylene using oxygen or air*

### MAJOR DERIVATIVES

*Ethylene glycol 60%, ethoxylates 10%, glycol ethers 10%*

### MAJOR END USES

*Antifreeze 30%, polyester 30%, surfactants 10%, solvents 5%*

### FOREIGN TRADE

*Exports and imports very small; derivatives traded in larger volumes*

### PRICES

*40 cents per lb, contract, in bulk; spot market very small*

### COMMERCIAL VALUE

*$1.7 billion for total production, 1979; $2.0 billion, 1980*

U.S. ethylene oxide producers could be facing a more difficult year in 1980 than might at first be indicated.

Production probably will be down only a small amount—possibly as little as 6%—to about the 1978 level of 5 billion lb from 5.3 billion lb in 1979. Such a decline would be less than that expected for many of the final products from ethylene oxide and its derivatives.

However, plant capacity for ethylene oxide is rising and is set to continue rising in 1980 and beyond. As 1980 opened, U.S. capacity was up nearly 15% from a year ago to about 6.4 billion lb. More capacity is on the way as producers complete expansions and debottlenecking.

Hence in 1980, ethylene oxide capacity will be run well below levels of recent years. If demand is enough to hold production at 5 billion lb, nameplate capacity use will be a bit less than 80%. In contrast, capacity use ran about 93% during 1979.

Periodically last year some derivatives of ethylene oxide, especially the glycol, became tight. One large unit at Calcasieu Chemical was shut down for most of the year. In addition, inventories were held down in anticipation that Oxirane's big new ethylene glycol plant would begin operations. As time went on and production from the new plant failed to meet industry expectations, a scramble for other supplies developed.

The glycol outlook is now completely changed. 1980 will not be a good year for the derivative, which takes about 60% of oxide production. All but a small part of ethylene glycol's U.S. consumption goes to two uses—antifreeze and polyester materials. Both these uses probably will decline more than 6% from 1979. Because ethylene glycol is just part of the total weight of these end products, the glycol volume involved will not be so great as for the end products but still will be substantial.

Antifreeze soon may lose its position as the largest single use of ethylene oxide. If antifreeze demand falls more than anticipated in 1980, polyester finally could pass it as the leading outlet.

In 1979, antifreeze sales increased about 4% from 1978, about twice as fast as the long-term forecast. But now that automobile sales are falling badly in the first half of 1980, original-fill antifreeze sales will decline more than might be expected from just the shift to smaller cars and smaller cooling systems.

In addition to the resulting decline of 5 million gal or so in original-fill antifreeze sales this year, unfavorable economic conditions will reduce replacement sales. One pessimistic forecaster believes that overall antifreeze sales will drop nearly 10% in 1980 to about 205 million gal. Such a drop could translate to a nearly 5% decline in ethylene oxide production.

If this weren't enough, poorer fortunes for polyesters in 1980 also would hurt ethylene oxide, but to a lesser degree. Ethylene oxide accounts for 10% of the weight of polyethylene terephthalate. As a result, a 5 to 10% polyester production decline in 1980 would have a minor effect on demand for ethylene oxide.

Other uses of ethylene oxide are varied and mostly small compared to glycol. One use, cyclic and acyclic ethoxylates, accounts for most of the actual merchant sales of ethylene oxide, although only a bit more than 10% of oxide production. Most of the rest of ethylene oxide is converted to derivatives by producers at the same site, and enters commerce in those forms.

Other products made from ethylene oxide, such as the di- and triglycols, polyethylene glycol, ethanolamines, and many others, will have varying fortunes during 1980. None of these consume ethylene oxide in large enough volume to have significant impact on total oxide production in the event of a major shift in demand.

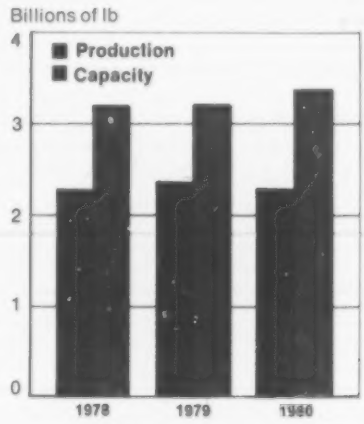
The smaller products with a potential upturn this year are the glycols and amines used in processing natural gas to remove water and acid gases. Changes in composition of natural gas as newer wells replace older wells and changes in processing technology are slowly causing an increase in use of these processing chemicals.

On balance, 1980 will be a downward blip in the growth curve for ethylene oxide. Producers have experienced such breaks before in oxide's slow growth trend, so won't be surprised by the accompanying pause in profitability growth.

# Cyclohexane

- ***Market soft***
- ***Capacity up a bit***
- ***Prices falling***

## PRODUCTION/CAPACITY




## HOW MADE

*Catalytic hydrogenation of benzene; recovery from natural gas condensates*

## MAJOR DERIVATIVES

*Adipic acid 65%, caprolactam 30%*

## MAJOR END USES

*Nylon 66, 60%; nylon 6, 30%*

## FOREIGN TRADE

*Exports—declining about 10% this year to about 400 million lb, imports—negligible*

## PRICES

*$1.72 per gal, contract, in bulk; spot market tiny*

## COMMERCIAL VALUE

*$500 million for total production, 1979; $600 million, 1980*

U.S. producers of cyclohexane will have a more difficult year in 1980 than in 1979, like producers of almost all other large-volume organic chemicals.

Production of cyclohexane in 1980 could turn out to be less than the 2.4 billion lb or 366 million gal in 1979, possibly 2.3 billion lb. This volume would mean that nameplate capacity of about 3.4 billion lb this year would be used at an average rate of just 68%. This is poor compared to rates for other major organic chemicals, although off only moderately from recent rates for cyclohexane.

Actually, cyclohexane will do well to come in even this close to 1979 production in 1980. The reason is a sizable market drop in progress in its major end use, nylon. For the first four months of 1980, nylon shipments were down 9% from the same period in 1979, according to the Textile Economics Bureau. And for fibers the worst may not be over.

Cyclohexane sources say that inventories may hold the key for cyclohexane stability this year. As 1980 began, inventories were low after a strong year in 1979. Factors were a good export business in 1979, considerable tightness in raw material benzene supply at times, and stout demand for nylon in carpets.

Hence, given low starting inventories, 1980 production of cyclohexane may hold up better than the general economic outlook suggests. Inventory building also may be helped by the value-added advantage of converting benzene to cyclohexane and by anticipation of an early bounce at the bottom of the recession. Even so, producers remember that nylon took two years to recover to its previous peak after the recession of 1974–75.

Amounts of cyclohexane going to major outlets are expected to fall off moderately for the full year in 1980. Exports, which account for about one sixth of production, will decline about 10% in 1980 or about 50 million lb. Carpet use, which accounts for well over half of nylon consumption, may fall sharply for a while, but chemical producers hope that aggressive promotion by carpet retailers will boost up sales later in the year.

Various other uses of nylon such as tire cord, apparel, and hosiery all face small changes in demand this year, in chemical producers' view. Tire cord use remains fairly strong because of the nonauto nature of this market, concentrated in truck, bus, and off-the-road vehicles.

In apparel markets, nylon is a mature fiber. A few of the many kinds of fabrics made with nylon could show sudden growth due to whims in fashion, but most are expected to hold where they are. Hosiery as a separate class of apparel use of nylon may show small growth but less than population growth.

On balance then, nylon probably will show a 1980 decline in carpet use offset partially by apparel. Cyclohexane exports will decline. The resulting net volume drop will be offset somewhat by inventory building to leave cyclohexane production a little lower than in 1979.

With nylon's negative outlook this year, cyclohexane's recent pattern of trailing nylon growth rates and excess capacity, can cyclohexane producers expect much at all in 1980 even in terms of their return on investment? Producers believe that several process factors still give them a chance.

For one, benzene weighs about 7.4 lb per gal, whereas cyclohexane weighs about 6.5 lb per gal. In effect, the hydrogenation of benzene produces more gallons of product. The product, although lighter, sells for 7 cents more a gal, or $1.72, compared to benzene's $1.65 by current postings.

Well, how about cyclohexane production costs? Certainly, there are operating costs for the raw material hydrogen and processing charges. However, depending on how the accounting is done, profitability doesn't have to be all that poor even with relatively low plant use rates. The accounting opens up many subjective estimates of costs, especially since all cyclohexane producers are petroleum refiners that can make their own starting materials. For example, the benzene going to cyclohexane can be considered incremental production, and the hydrogen can be priced low at its fuel value in the refinery's fuel gas stream.

Hence, even with a difficult year in 1980, producers of cyclohexane may not have so poor a year financially as economic conditions stemming from nylon demand would suggest.

# Industry leery of natural rubber agreement

**International pact would set up natural rubber stockpile to buffer price fluctuations, but many experts say system is unrealistic and won't work**

Congress has cleared the way for the U.S. to take part in the International Natural Rubber Agreement.

Last month, both the House and the Senate passed legislation authorizing the appropriation of $88 million that the Administration requested to participate in what it is calling a "model commodity agreement." And the Senate, by a 90 to 1 vote, ratified the agreement.

That makes the U.S. the first major natural rubber importing country to ratify the agreement, which is supposed to become operative this October. Malaysia, by far the largest natural rubber producer, was the first country to ratify the agreement when it took the step earlier this year.

When the House Foreign Affairs Committee approved the appropriation, Rep. Jonathan Bingham (D.-N.Y.), chairman of the Subcommittee on International Economic Policy & Trade, told the committee that U.S. participation in the effort to stabilize natural rubber prices would in no way harm the U.S. rubber industry.

Perhaps not. But with the exception of the Rubber Trade Association (RTA), the U.S. rubber industry isn't particularly ecstatic about the proposition.

RTA, which is based in New York City, handles about 65% of all natural rubber imports into the U.S. and distributes them to all segments of the U.S. rubber industry. According to RTA president A. F. Scheuer, U.S. participation in the rubber agreement is preferable to having the producer countries go it alone.

The Rubber Manufacturers Association (RMA), however, is dead set against the agreement. First, it opposes the agreement on principle. RMA president Malcolm R. Lovell Jr. says that the association has always opposed artificial regulation of natural rubber's price and availability.

But RMA, which represents more than 200 U.S. manufacturers of rubber products, has a more practical reason for its negative attitude toward the agreement.

Most of the $88 million being earmarked for U.S. participation in the agreement will be used to build up an international natural rubber stockpile or buffer stock. This buffer stock, targeted to accumulate 550,000 metric tons of natural rubber, is designed to act as a stabilizing influence on natural rubber's price, which has a history of wild fluctuations.

The agreement calls for an initial reference price of about 45.4 cents per lb with bands of ±15% and ±20%. Thus, if natural rubber's price falls between 15 and 20% below the reference price, the buffer stock manager has the option of buying or not buying rubber for the stockpile. If the price falls below 20%, he must buy.

Similarly, on the high side, if the market price jumps to between 15 and 20% of the reference price, the manager can choose to sell or not sell. But if it goes more than 20% higher, he must sell.

The problem is that this price arrangement bears no practical relationship to today's natural rubber prices. Recent prices for RSS-1 grade (a reference grade) rubber have been running about 67 cents per lb on the New York market. They had been even higher until U.S. auto makers ran into trouble and pulled the skids out from under the tire market.

Even at 67 cents, natural rubber's market price is 48.6% above the proposed initial reference price under the agreement. It also is 12.5 cents above the upper 20%-band price, which means that the buffer stock manager would have to sell, not buy rubber under current market conditions.

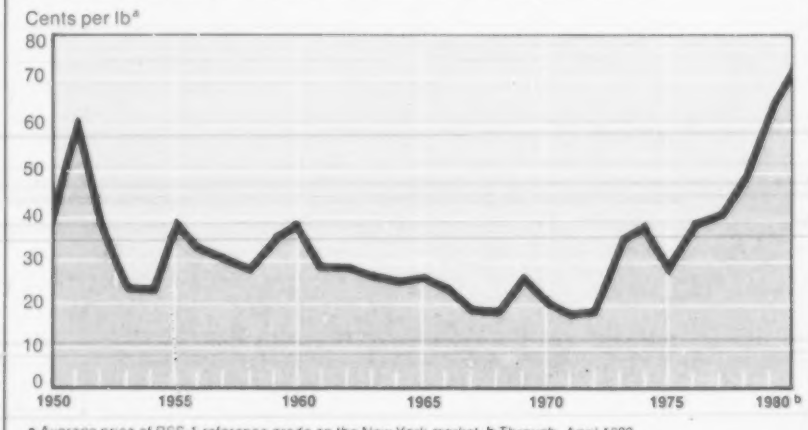
Given the budget constraints facing Congress, RMA's Lovell doesn't think that the $88 million should be appropriated when it is "abundantly clear that [it] cannot be used for the purpose proposed."

A. J. Ashe, senior vice president of B. F. Goodrich Co., is more explicit. "It's a waste of taxpayers' money," he says.

Personally, Ashe, with his background in economics, is opposed to anything that interferes with a free market. However, he considers himself a strong proponent of the agreement because it's "as good as we can get" and will have a minimum of interference in the market.

But Ashe, too, thinks that the timing is bad. Under today's market conditions, the buffer stock manager would have to sell natural rubber from the stockpile. But, Ashe says, he can't sell something he doesn't have. For the manager even to have the option of buying, the price of natural rubber would have to drop to about 38 cents per lb. And, with the price

**Price instability behind natural rubber agreement**




a Average price of RSS-1 reference grade on the New York market. b Through April 1980.
Source: World Bank data

**Malaysia produces nearly half of world's natural rubber; U.S. consumes almost fourth of total**

a Percentage of net exports in the five-year period 1974 to 1978. b Percentage of net imports in the three-year period 1976 to 1978. **Source:** United Nations Conference on Natural Rubber

now running around 67 cents, Ashe doesn't see that happening soon. In fact, he doesn't think that the agreement will be able to operate as intended during its first five years.

So to Ashe, the proposed international rubber agreement is academic. And he thinks that the $88 million that the U.S. wants to spend on it will do little more than create an unnecessary bureaucracy and subsidize attendance at meetings around the world.

He even doubts that the agreement can do the job that it's designed to do. The proposed inner bands of ±15% amount to a 30% price spread, or a range of almost 14 cents. Although natural rubber prices have, indeed, fluctuated widely in the past, Ashe says that a 30% swing has happened only very few times in the past 20 years. So as a price stabilizer, he believes that the agreement is "nonsense."

One other thing that bothers some U.S. rubber companies is whether producing countries will take the steps necessary to guarantee increased natural rubber production. RMA's Lovell says the Senate shouldn't have ratified the agreement until it became apparent that producing countries, in fact, were attempting to increase output.

Such fears may be unfounded, however. Those familiar with the agreement say that it provides mechanisms for expanded production. And, unlike other commodity agreements, it virtually precludes use of export controls by producing countries.

Malaysia, which accounts for about half of all natural rubber exports, already has taken steps to encourage increased production. It has reduced export taxes on natural rubber about 20%. These taxes tended to encourage Malaysians to use their land for other crops, such as palm oil, instead of rubber. The country also has a billion-dollar development plan under way to boost rubber production.

However, these and other production incentives may not be enough. At a recent meeting of the International Institute of Synthetic Rubber Producers in Mexico, John J. Riedl, Goodyear's plantation manager, forecast tight natural rubber supplies in the 1980's. He estimates that natural rubber supply will increase an average 3.2% per year during the decade. But, he adds, demand probably will outdistance supply. Even pessimistic estimates peg 1990 worldwide natural rubber consumption at about 5.85 million metric tons. That's 52% higher than present rates. To reach that 1990 consumption figure, Riedl says, Malaysia and Indonesia, the two leading natural rubber producers, would have to increase their output 1.3 million tons, or about 300%. And they managed to raise production only less than 400,000 tons over the past 10 years.

Those are the economic realities facing the international rubber agreement when—and if—it becomes effective in October. To become effective, it must be ratified by governments accounting for at least 80% of net exports and governments accounting for at least 80% of net imports.

*Earl Anderson, New York*


# Chemistry and the Food System

*A Study Report by the ACS Committee on Chemistry and Public Affairs*

**Vital reading for everyone concerned with this important public policy issue.**

This report describes how a range of chemical substances — including fertilizers, pesticides, plant growth regulators, drugs to control animal diseases, and nutritional supplements — have clearly provided benefits in the production, storage, and processing of foods from both plants and animals.

Attendant benefits, disadvantages, problems, and risks are all fully discussed with the aim of providing public policy makers with the necessary information and recommendations needed in their formulation of public policy.

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